A Monetary Policy Feedback Rule in Korea's Fast-Growing Economy

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Abstract

In Korea's high-growth economy, the Bank of Korea had been willing to tolerate double-digit inflation, provided that it remained at 'non-explosive' levels. In this article, we estimate a monetary policy feedback rule for Korea and find that the upper threshold of tolerable inflation for the Bank of Korea was about 20 percent. It appears that the Bank of Korea's disciplined, rule-like approach to monetary policy was able to control inflation and keep it away from explosive levels, despite the well-know empirical regularity that inflation becomes more variable at higher levels. After 1983, however, our regime-switching model suggests that the inflation target has been six percent. We also find little evidence that the Bank of Korea has targeted real growth, except for a period in the mid-1980s when industrial production growth suggested that the economy was overheating, relative to an implicit growth target of 7.4 percent. We conclude with a discussion of possible reasons for Korea to choose to stabilize inflation at lower levels since the mid-1980s.

Keywords: Inflation targeting, policy rule, Markov switching

JEL Classification: C50, E52, E58

Michael Dueker
Research Officer
Federal Reserve Bank of St. Louis
411 Locust Street
St. Louis, MO 63102
mdueker@stsl.frb.org

Gyuhan Kim
Dept. of International Economics
Sang Myung University
Seoul, Korea

Introduction

In response to the growing consensus in favor of price stability as the primary goal of monetary policy, economists have proposed a number of feedback mechanisms aimed at committing policy to a long-run nominal target [McCallum (1988, 1994); Judd and Motley (1993)]. The proposed feedback mechanisms prescribe changes in an operating target variable that the central bank can control. Much empirical work has concentrated on simulations of feedback rules in order to learn about their properties [McCallum (1988, 1994); Judd and Motley (1993)]. The procedure can be inverted, however, to use policy feedback rules as models of policy and the associated data [Dueker and Fischer (1996)]. In this article, we use a feedback rule to examine the implicit policy targets of the Bank of Korea and to examine whether Korean monetary policy behaved in a disciplined, rule-like manner, even though its implicit inflation target was well above the levels seen in other countries that have explicit inflation targets.

The Bank of Korea's delicate mission for the first half of our 1973-95 sample was to allow rapid growth in domestic credit to foster growth, while keeping inflation just below an explosive level at which inflation could easily spiral upward to hyperinflation. In general, monetary policy in Korea has been encharged with accommodating Korea's impressive growth, even to the point of shepherding growth in targeted sectors by using its influence on private banks to direct loans and investment capital. As the Korean economy developed, government policymakers recognized that sustained growth would require a more advanced

and less regulated financial system. In addition, an efficient financial system would only evolve in an environment of lower inflation, below double digits. Our results suggest that Korea's monetary policy was perhaps surprisingly disciplined and rule-like in pursuit of objectives that underwent a transition to lower inflation in the early to middle 1980s.

The next sections briefly review strategies and institutional detail for the Bank of Korea. The subsequent sections present the empirical model and results.

Strategies of the Bank of Korea

For the past 50 years, the Bank of Korea has consistently concerned itself with fostering Korea's rapid economic growth and development [Bank of Korea (1995)]. Towards this end, however, the contribution of monetary policy has alternated between accommodative and stabilizing stances with respect to price inflation. In this period, monetary policy did not use the exchange rate as an indicator variable, because the exchange rate was not market-determined but controlled by the authorities to prevent undesired exchange rate appreciations from making Korean exports less competitive in the world market. During the late 1950s, monetary policies were aimed at alleviating the high inflation rates that prevailed after the Korean War. From the early 1960s when the first economic development plan began, monetary policy was frequently used to speed up economic growth by increasing the growth rate of the money supply and directing financial resources to targeted sectors in export industries. In the 1970s, especially, the government encouraged hurried expansion in the heavy and chemical industries to sustain a high rate of economic growth.

Monetary authorities in this period were deeply involved in mobilizing financial resources to accommodate large rates of investment in these industries [Bank of Korea (1992)]. One reason for the high inflation seen in Korea was that Korea often experienced large current account surpluses that the Bank of Korea could hardly offset to prevent rapid growth in the money supply [Bank of Korea (1990)]. Because of the high resulting inflation, financial deregulation was postponed.

The export-oriented growth strategy of the 1960s and 1970s led to high inflation and the realization that such levels of monetary stimulus actually undermined the country's capacity utilization and financial development. Moreover, the second oil shock in 1979 drove Korean economy into stagflation. At the stage of the economy's development in the early 1980s, the Korean government recognized that sustained growth would require financial liberalization, and lower inflation was essential for successful financial liberalization. Thus, although sustainable economic growth remained the chief goal of overall economic policy, price stabilization became the best contribution that monetary policy could make. It is generally acknowledged that financial deregulation and the opening of financial markets have enhanced Korea's market mechanisms since the mid-1980s. During the 1980s, all existing commercial banks were privatized and some new commercial banks received charters. Interest rate liberalization progressed and the domestic stock market was partially opened to foreign investors in the early 1990s. Reflecting the change in monetary policy objectives in Korea from economic growth to price stabilization, the growth rate of money supply was much lower in the 1980s than in the 1960s and 1970s, as shown in Figure 1.

In order to tackle the problem of high inflation while accommodating rapid economic growth, the Bank of Korea has adopted monetary targeting. A target growth rate for M2 has been set at the beginning of each year since 1979.[1] Since interest rates were not market-determined until Korea began to pursue interest rate liberalization in 1991, they were not good indicators of the stance of monetary policy.[2] For most of the post-war period, credit was rationed, with interest rates held below market-clearing levels. But non-price credit rationing has been fading and interest rates have become a more important tool of monetary control in recent years.

From 1979 to 1985, the target growth rate of M2 continued to decrease from 25% to 9.5%, bringing a substantial tightening in monetary policy. Subsequently the M2 target rate was raised to 16-18% during the period of hugh current account surplus (1986-1989), but has gradually been reduced to 12-16% in 1995. The target growth rate for M2 has been determined largely by the European Community method of using estimates of potential real growth, unavoidable near-term inflation and expected velocity growth and deriving implied money growth from the equation of exchange.[3] Table 1 shows how close actual M2 growth has been to the target rates since 1979. With the exception of 1983 and 1984, actual M2

[1]Monetary targeting formally began in 1976 when the Bank of Korea announced growth targets for M1. Before that time, the Bank also had to agree to targets for growth in the monetary base and domestic credit as part of Stand-By credit agreements with the International Monetary Fund, but these did not guide monetary policy actions operationally.

[2]Barro and Lee (1994) argue, however, that Korean interest rates neverthelss fluctuated around equilibrium levels, based on the reduced-form regressions they study.

[3]For example, the 1995 M2 target growth rate of 12-16% was calculated based on an assumption of 7% real growth, 5% unavoidable inflation, and a decline in velocity of 2%. In recent years, the target range has been widened due to increased uncertainty about the effects of financial market liberalization and the opening of the country's capital markets.

growth has been within or above the target range. In the early 1980s, M2 growth targets were set above 20% to counteract the economic recession. In the middle of the 1980s, the central bank did not completely sterilize the monetary expansion resulting from the large accummulation of current account surplus.

Table 1: Official Target and Actual M2 Growth Rates in Korea

year	Target	Actual
1979	25	24.6
1980	20(25)	27.0
1981	25	25.2
1982	20-22(25)	27.0
1983	18-20(15)	14.7
1984	11-13	8.9
1985	9.5	13.9
1986	12-14(16-18)	17.4
1987	15-18	22.5
1988	15-18	18.8
1989	15-18	18.4
1990	15-19	21.2
1991	17-19	18.3
1992	18.5	18.6
1993	13-17	17.3
1994	14-17	17.6
1995	12-16	13.7
Intra-year revisions to targets are in parentheses		

The fact that actual M2 growth has not been particularly constrained by the target ranges set at the beginning of each year suggests that the money supply has responded to intra-year developments, perhaps in a manner akin to the feedback mechanism we present in the next section.

Institutional Details for the Bank of Korea

Several features of the way the Bank of Korea has conducted monetary policy helped determine which variable we used as the policy information variable for Korea. First, interest rates were not market determined for the early part of our sample period. While financial liberalization has progressed rapidly in recent years, interest rates do not provide a reliable guide to policy actions early in our sample, because they were not market-clearing interest rates. Private banks, sometimes under consultation with the Bank of Korea, would ration loan demand at prevailing rates. In this way, investment flowed to favored sectors at susidized, below market-clearing, rates and, therefore, interest rates do not provide a consistent measure of the stance of monetary policy. A second possibility, the monetary base or reserves, was ruled out because reserve requirement changes have been relatively frequent in Korea. To some extent, the Bank of Korea has used reserve requirement changes as a valve to adjust the flow of profits to the banking sector. Our chosen measure of policy information is the monetary aggregate M2. Given that bank loans are the assets that correspond with the banks' deposit liabilities that enter M2, and that bank lending and M2 respond to interest rate pressures, reserve requirement tax pressures and moral suasion from the cental bank, M2 growth appears to be the best summary measure expressing the intentions of the Bank of Korea.

An Empirical Model of Korean Monetary Policy

In our empirical work, we assume that the Bank of Korea steers M2 growth with inflation as its ultimate nominal target. In this case forecasts of real money demand provide an

important link between the operating target and the policy objective. We use a time-varying coefficient model based on the Kalman filter to generate plausible one-step-ahead forecasts. A few words about our use of externally generated forecasts versus internal (and unavailable) Bank of Korea forecasts are in order. Since we do not have internal Bank of Korea forecasts and because the Bank of Korea may not even have had specific inflation targets for all years, we cannot claim to be uncovering explicit Bank of Korea inflation targets with our model. We can say, however, that our use of reasonable, technically sophisticated forecasts gives us sound inferences regarding *implicit* policy objectives of the Bank of Korea. Central banks, regardless of their internal targets and objectives, remain cognizant of the implicit signals they send with respect to their inflation tolerances in that the public can ascribe observed money growth rates to likely inflation outcomes through such forecasts. The parameters corresponding with the implicit inflation targets in our empirical model represent these likely inflation outcomes that the public, including the central bank, would expect to result from the chosen monetary policy.

It should also be noted that our Kalman filter forecasts use data only up to the current date in estimating the coefficient values, in contrast to OLS coefficients which embody sample-wide information. In addition to a current-period inflation target, our model allows for the possibility that monetary policy responds to a deviation in the price level from an implicit target price level and also to a deviation in the industrial production index and an implicit target level. As discussed above, monetary policy cannot achieve arbitrary targets for real variables, such as industrial production, in the long run, but monetary policy

can take short-term feedback from real variables. We included feedback from industrial production, because the Bank of Korea has shown concern not only with helping to sustain Korea's high growth rate, but also with stabilizing some of the volatility in the growth rate. Since monetary policy cannot choose arbitrary targets for real variables in the long run, our model feedback mechanism allows the industrial production index to have an implicit target, where the target is adjusted gradually to accommodate actual long-run developments.

We note M2 growth as $\Delta lnM2$, the price level as P, a forecast of growth in real M2 demand as $\Delta ln(M/P)$, the target inflation rate as λ_0, the industrial production index as IP and the desired price level and industral production level as $\hat{P}$ and $\widehat{IP}$, respectively.[4] We use a monthly sample that covers 1973-95. The parameters in our model switch over time according to three state variables that follow independent first-order Markov processes:

$$S1 \in \{0,1\}; \qquad S2 \in \{0,1\}; \qquad S3 \in \{0,1\}.$$

Parameter dependence on these state variables is indicated by placing the appropriate state variable in parentheses following the parameter. The feedback mechanism we use to model Korean monetary policy is

[4]All data used in this article were supplied by the Bank of Korea.

$$\begin{aligned}\Delta lnM2 &= \lambda_0(S1_t) + \Delta ln(M/P)_{t|t-1} + \lambda_1(S1_t)(ln\hat{P}_{t-1} - lnP_{t-1}) \\ &\quad +\lambda_2(S2_t)(ln\widehat{IP}_{t-1} - lnIP_{t-1}) + \epsilon_t \qquad (1)\end{aligned}$$

The variance of the error term is not assumed to be constant to reflect the fact that the model will not describe the data with equal precision in all time periods:

$$\text{var}(\epsilon_t) = \sigma^2(S3_t).$$

The target paths for the price level and industrial production index evolve according to equations (2) and (4):

$$\begin{aligned}\text{Target Price Level: } ln\hat{P}_t(S1_t) &= \lambda_0(S1_t) + \delta_1(S1_t)ln\tilde{P}_{t-1} + (1 - \delta_1(S1_t))lnP_{t-1}, \qquad (2) \\ \text{Expected target: } ln\tilde{P}_t &= \sum_{i=0}^{1} \text{Prob}(S1_t = i \mid Y_t)ln\hat{P}_t(S1_t = i), \qquad (3) \\ \text{Target Ind. Prod: } ln\widetilde{IP}(S2_t) &= \mu(S2_t) + \delta_2(S2_t)ln\widetilde{IP}_{t-1} + (1 - \delta_2(S2_t))lnIP_{t-1}, \qquad (4) \\ \text{Expected target: } ln\widetilde{IP}_t &= \sum_{j=0}^{1} \text{Prob}(S2_t = j \mid Y_t)ln\widehat{IP}_t(S2_t = j). \qquad (5)\end{aligned}$$

The variables $\hat{P}$ and $\widehat{IP}$ are, respectively, the target price level and the target level for the industrial production index conditional on particular values of the markov state variables. The expected values are derived by integrating out the current values of the state variables.

Rebasing of the target level occurs for values of $\delta_1, \delta_2 < 1$. Consequently, one-time shifts in the price level are gradually accommodated into the target path. As δ decreases from one, the degree to which the target level is allowed to drift to accommodate recent developments increases. McCallum (1993) has used an analogous weighting scheme; however, in his model δ_1 remains constant.

Because of the autoregressive nature of equations (2) and (4), inferences of the state at time t would depend on the entire history of past realizations of the state variables if it were not for the collapsing procedure shown in equations (3) and (5). Kim (1994) provides the justification for the collapsing procedure and notes that its use introduces a small approximation to the evaluation of the likelihood function in a markov-switching model. He finds, however, that the approximation does not materially affect the calculated value of the likelihood function or the parameter estimates.

The three Markov processes are assumed to undergo transitions between their states independently from each other for reasons of tractability. In this case, the transition probabilities can be summarized as

$$\begin{aligned}
\text{Prob.}(S1_t = 0 \mid S1_{t-1} = 0) &= p_1 \\
\text{Prob.}(S1_t = 1 \mid S1_{t-1} = 1) &= q_1 \\
\text{Prob.}(S2_t = 0 \mid S2_{t-1} = 0) &= p_2 \\
\text{Prob.}(S2_t = 1 \mid S2_{t-1} = 1) &= q_2 \\
\text{Prob.}(S3_t = 0 \mid S3_{t-1} = 0) &= p_3 \\
\text{Prob.}(S3_t = 1 \mid S3_{t-1} = 1) &= q_3
\end{aligned}$$

Note that without the independence assumption, we would have to estimate 64 transition probabilities instead of six. The unconditional value of $S1 = 0$, for example, is $\frac{1-q_1}{2-p_1-q_1}$.

Maximum-likelihood estimates of the parameters are obtained by maximizing the log of the expected likelihood or

$$\sum_{t=1}^{T} ln \left(\sum_{i=0}^{1} \sum_{j=0}^{1} \sum_{k=0}^{1} \text{Prob.}(S1_t = i, S2_t = j, S3_t = k \mid Y_{t-1}) L_t^{(i,j,k)} \right) \tag{6}$$

where Y_{t-1} is information available through time $t-1$ and the student-t densities are

$$\begin{aligned} lnL_t^{(i,j,k)} &= ln\Gamma(.5(n+1)) - ln\Gamma(.5n) - .5ln(\pi n \sigma^2(S3_t = k)) \\ &\quad -.5(n+1)ln\left(1 + \frac{\widehat{\epsilon}(S1_t = i, S2_t = j)_t^2}{n\sigma^2(S3_t = k)}\right) \end{aligned} \tag{7}$$

and Γ is the gamma function.

Empirical Results for Korea

The two-state Markov switching characterization of the Bank of Korea's implicit inflation target uncovers estimates of six percent inflation in the low state and slightly greater than twenty percent in the high state.[5] Table 2 contains the full set of parameter estimates

[5]Note that the two-state characterization is not as restrictive as it might first appear, because the states are only inferred probabilistically. Thus, the inferred inflation target can lie anywhere between six and twenty percent, depending on the filtered probability of being in the low-inflation state.

for the model and Figure 1 shows the probability-weighted inferred inflation target with a one-year moving average of actual inflation. The Bank of Korea has been in the low-inflation state since the early 1980s, in conformity with the world-wide disinflation. For a period in the mid-1980s, actual inflation remained substantially under six percent. Our estimates suggest that part of this differential in the mid-1980s may have resulted from attempts to prevent the real economy from overheating. Figure 2 plots the probability of being in the state in which money growth admits a low level (essentially zero) of feedback from the industrial production index. The non-zero feedback state ($\lambda_2(S2 = 1) = .084$) pertained in the mid-1980s. Figure 3 shows that moderate feedback was taken when the industrial production index was generally racing ahead of a path defined by a growth path of $\mu(S2 = 1) = 7.4$ percent. For this reason, we conclude that the mid-1980s represented the only period in the sample when the Bank of Korea responded directly to concerns that the Korean economy was overheating due to unsustainably fast growth in industrial production.

Table 2: Models of Inflation Targeting (eqns. 1-6): 1974:1-1994:12		
parameter	**Model 1** no restrictions	**Model 2** restricted model
$\lambda_0(S1=0)$ *inflation target: low state*	6.86	6.86 (1.08)
$\lambda_0(S1=1)$ *inflation target: high state*	20.14	20.14 (1.61)
$\lambda_1(S1=0)$ *price level feedback*	1.3E-7	set to zero
$\lambda_1(S1=1)$ *price level feedback*	7.8E-6	set to zero
$\delta_1(S1=0)$ *price target drift*	.247	N.A.
$\delta_1(S1=1)$ *price target drift*	.195	N.A.
$\mu(S2=0)$ *ind. prod. growth target: low state*	2.2E-6	0
$\mu(S2=1)$ *ind. prod. growth target: high state*	7.43	7.43 (2.69)
$\lambda_2(S2=0)$ *ind. prod. feedback*	1.3E-7	set to zero
$\lambda_2(S2=1)$ *ind. prod. feedback*	.084	.084 (.022)
$\delta_2(S2=0)$ *ind. prod. target drift*	.815	.815 (.076)
$\delta_2(S2=1)$ *ind. prod. target drift*	.974	.974 (.036)
$\sigma^2(S3=0)$ *low variance*	.441	.441 (.129)
$\sigma^2(S3=1)$ *high variance*	2.28	2.28 (.860)
p_1	.990	.990 (.009)
q_1	.996	.996 (.005)
p_2	.987	.987 (.011)
q_2	.980	.980 (.016)
p_3	.833	.833 (.097)
q_3	.665	.665 (.129)
Log-Likelihood	14-452.72	-452.73
No. of parameters	21	15
Note: Standard errors in parentheses for restricted model.		

The parameter estimates of λ_1 find no evidence of Korean monetary policy admitting feedback from the price level, which implies that the inflation rate is targeted period by period. Figure 4 plots the filtered probability of the low volatility state. In this state, the residual variance is low: $\sigma_t^2 = \sigma^2(S3 = 0) = .441$. The residual variance between monthly M2 growth and the model-implied rate of M2 growth is about five times higher in the high-variance state, $\sigma_t^2 = \sigma^2(S3 = 1) = 2.28$. Figure 4 shows that high-volatility periods are not persistent and are distributed quite evenly throughout the sample period.

Finally in Figure 5, we assess the fit of the feedback model in explaining Korea's M2 growth. The estimation was carried out using monthly data, but for clarity the chart plots year-over-year growth rates. The chart shows much wider swings in M2 growth prior to the mid-1980s, after which M2 growth has settled at a mean rate near 15 percent. The model-implied M2 growth rate declined more slowly than actual M2 growth in the disinflation of the 1980s. We would expect, however, the model-based inferences to be conservative when identifying major changes in the inflation target, given that the high-inflation state is highly persistent, with $q_1 = .996$. In this case, the model will have to see below-normal inflation for a substantial period before concluding that the target rate of inflation has fallen. Moreover, there is reason to believe that the inflation rate and money growth fell more rapidly in 1983 than the Bank of Korea had expected. Table 1 shows the Bank of Korea's pre-set target M2 growth rates and the intra-year revisions to the targets, where applicable. In 1983, the Bank of Korea expected M2 growth to be between 18 and 20 percent, but realized later that year that 15 percent would be appropriate.

Conclusions

In this article we estimate a monetary policy feedback rule to describe Korean monetary policy over the past 20 years. Our estimates for the implicit inflation target show that, prior to the mid-1980s, monetary policy attempted to cap inflation at 20 percent, but undertook little action to push the rate down when it was below 20 percent. Apparently the objective was to keep the inflation rate from becoming explosively high, and this threshold was operationally 20 percent. Since the 1980s, however, inflation has been maintained at a level below 10 percent, with an implicit target of about 6 percent.

Given the dictum that inflation becomes more volatile at higher rates, Korea's inflation rate showed suprisingly little variation during the period when the inflation target was about 20 percent. Much of the variation that did occur coincided with the twin oil shocks that affected all the industrialized countries as well. Hence one policy implication of our results is the claim that rule-like monetary policy can succeed in stabilizing inflation, even at the supposedly unstable rate of 20 percent. This finding ought to encourage central banks that are contemplating a commitment to inflation targeting at low rates of inflation, where the rate is less volatile.

In addition, several interesting questions arise when one asks why the Bank of Korea lowered the inflation target in the 1980s. First, was 20 percent inflation incompatible with liberalized financial markets? Ottmar Issing of the Deutsche Bundesbank notes that "Financial markets have become an important ally in implementing a stability-oriented

monetary policy ... one might even go so far as to say that the high inflation rates of the past destroyed the very basis of the existence of inflation by drawing the attention of the financial markets to the dangers of an easier monetary policy." [Issing 1996, pp. 290-91]. Of course, disinflation took place globally in the early 1980s, so more than Korea's nascent domestic financial markets were pointing towards disinflation. The influence of global inflation trends on Korean inflation was clear in the 1970s, as the twin oil shocks affected Korean inflation disproportionately. Second, was the liberalization of financial markets necessary to sustain high growth rates as Korea's economy matured and income levels began to reach OECD levels? The answer to this question may well be affirmative, but our findings suggest that the timing may have been opportune. The disinflation and financial liberalization in the 1980s coincided with the only period in the sample when monetary policy was concerned about an overheated economy. Thus, one might argue that the Bank of Korea only acted to disinflate when the real economy had considerable momentum and could best withstand a disinflation. Finally, one might ask whether grass-roots support for low-inflation policies would have appeared spontaneously, as the Korean people acquired more wealth to protect and invest.

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Figure 1

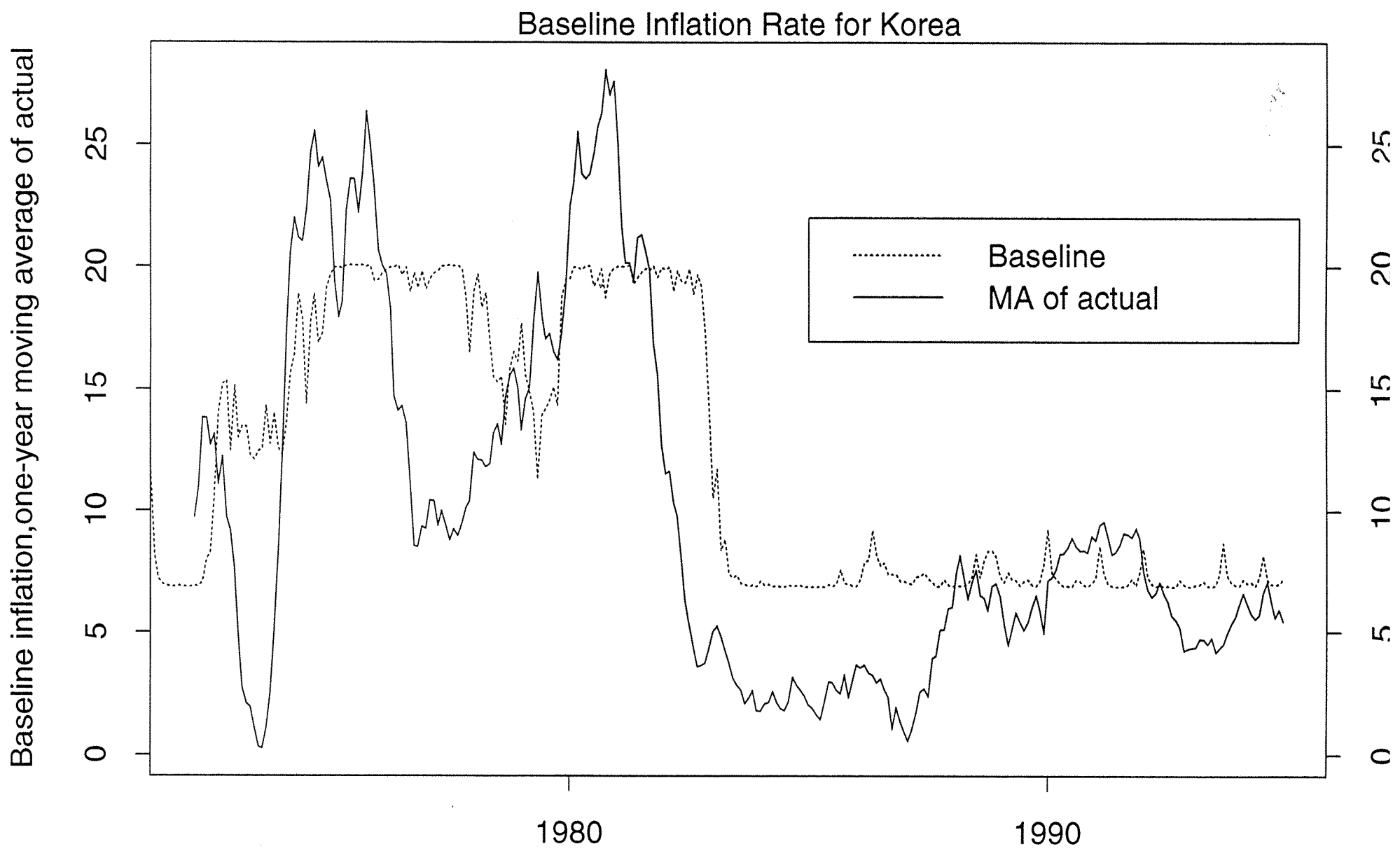

Baseline Inflation Rate for Korea
Baseline inflation,one-year moving average of actual
0
5
10
15
20
25
1980
1990
Baseline
MA of actual

Figure 2

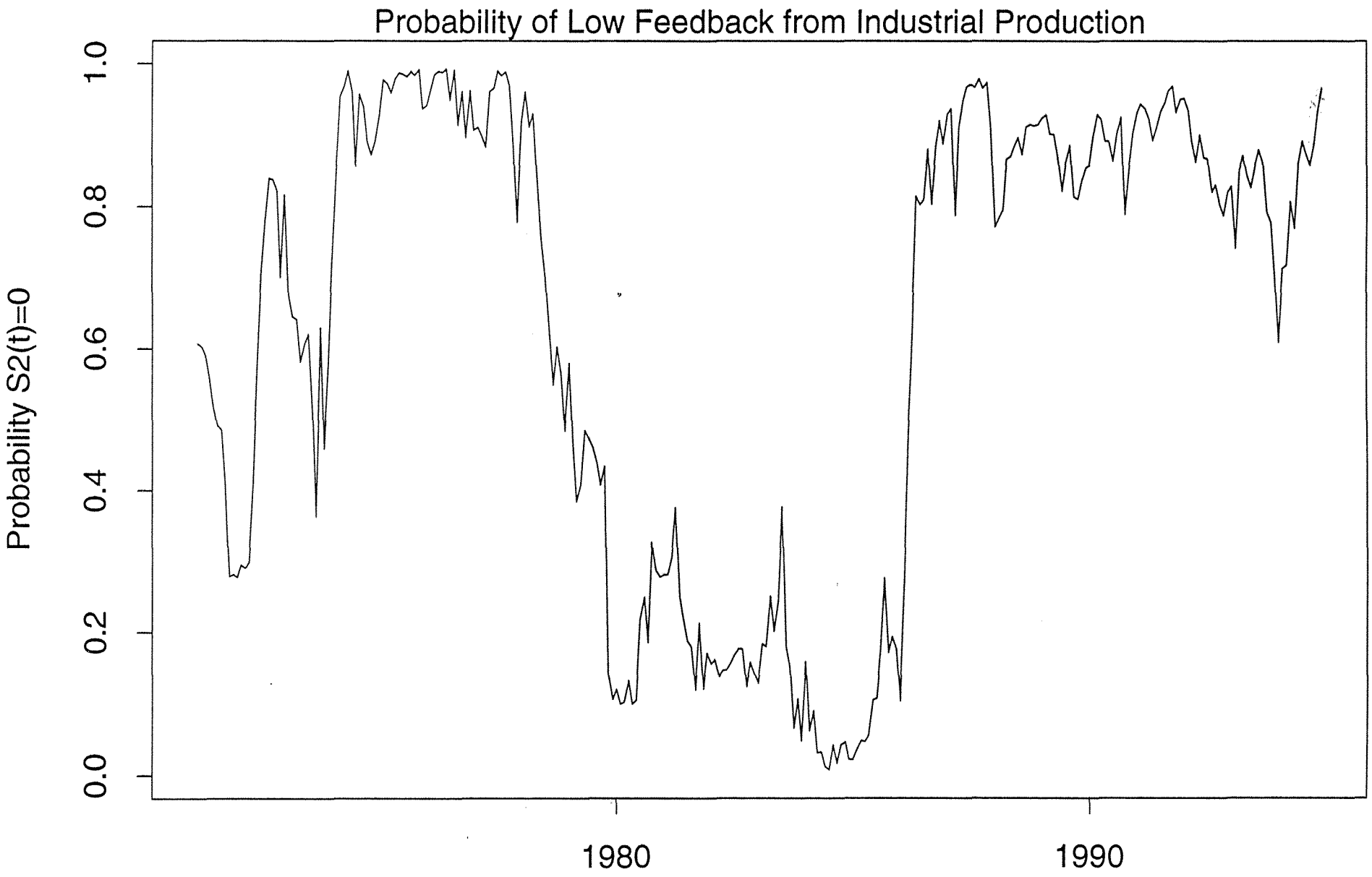

Probability of Low Feedback from Industrial Production
Probability S2(t)=0
0.0
0.2
0.4
0.6
0.8
1.0
1980
1990

Figure 3

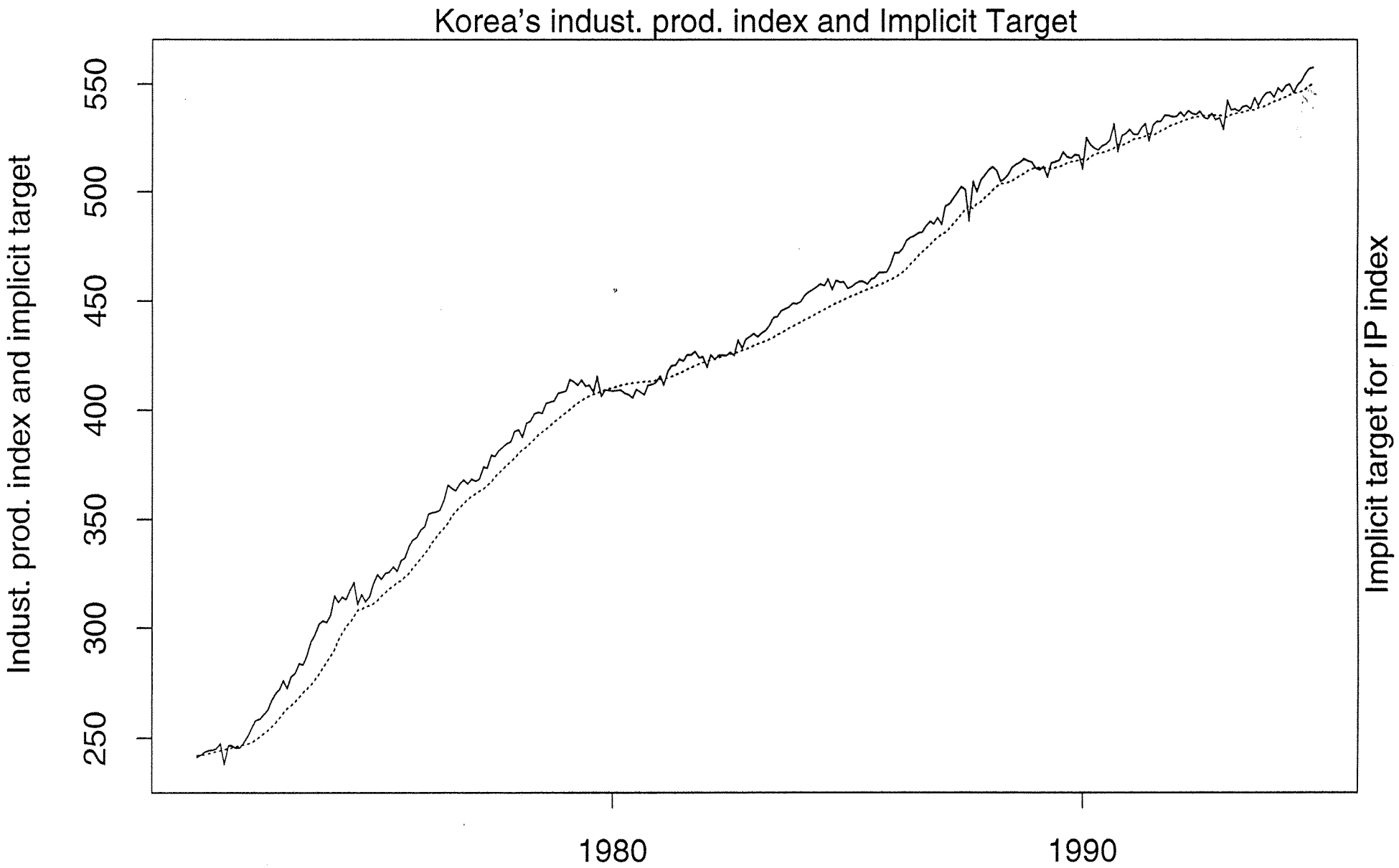

Korea's indust. prod. index and Implicit Target
Indust. prod. index and implicit target
Implicit target for IP index
250
300
350
400
450
500
550
1980
1990

Figure 4

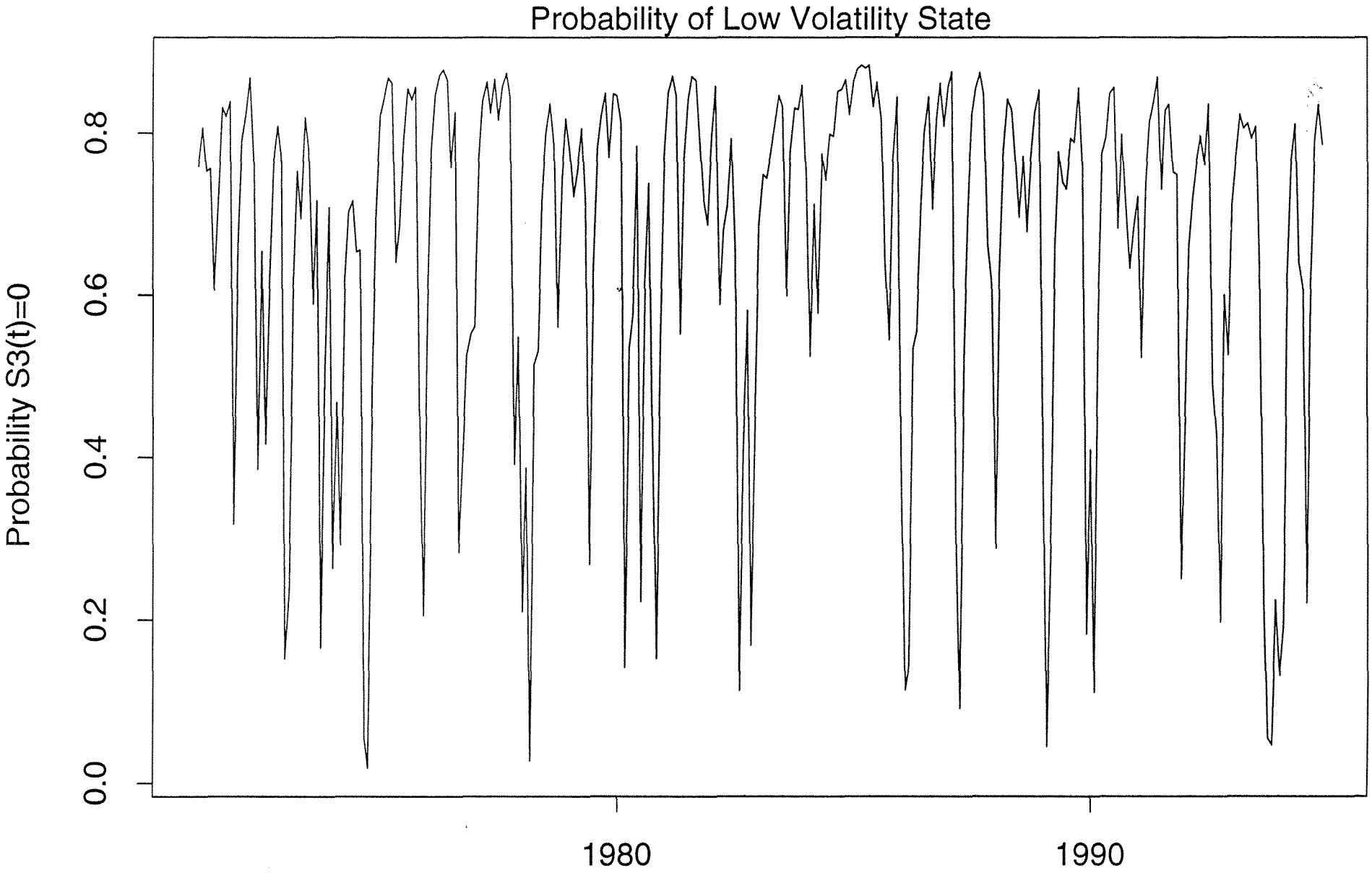
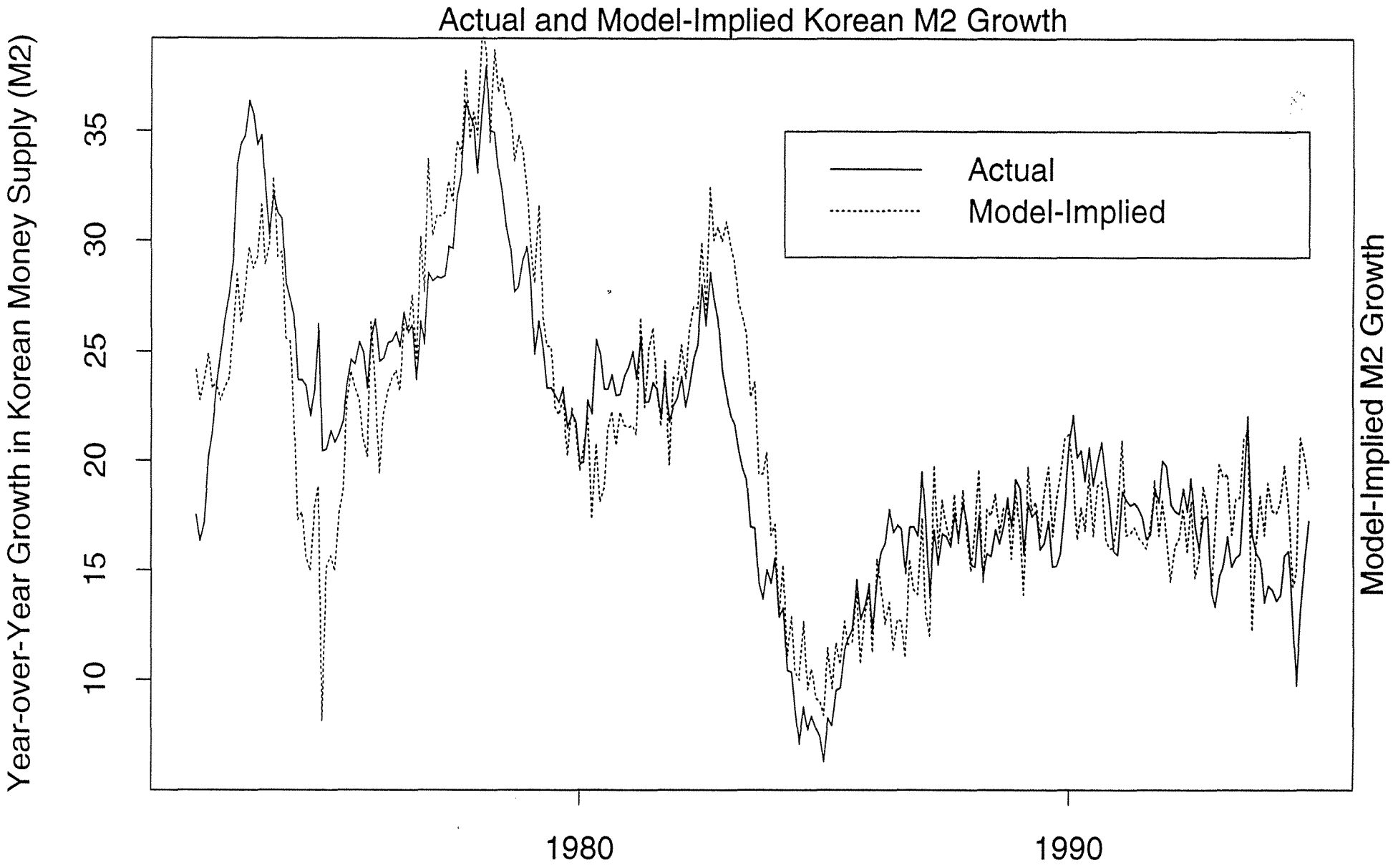

Probability of Low Volatility State
Probability S3(t)=0
0.0
0.2
0.4
0.6
0.8
1980
1990

Figure 5


Actual and Model-Implied Korean M2 Growth
Year-over-Year Growth in Korean Money Supply (M2)
Model-Implied M2 Growth
10
15
20
25
30
35
1980
1990
Actual
Model-Implied